High-Performance Computational Electromagnetic Modeling Using Low-Cost Parallel Computers

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This paper discusses the use of low-cost parallel computers, specifically the Beowulf system which was built at Caltech, to solve problems in computational electromagnetic. The focus of this paper is on application of the Finite-Difference Time-Domain (FDTD) method. Some discussion of applying the Finite-Element (FE) method to this type of machine is also be provided,

The Beowulf systems is composed of *16 200* MHz Pentium Pro-based personal computers connected with a fast 16-way crossbar switch. The hardware parts used to build the system are all commodity components, costing less that $60,000 for the entire system, and all the software used (compilers, operating system, etc...) is freeware. The highest sustained application speed measured on this system is *1.2* GFlops.

As the FDTD method can be parallelized through a simple domain decomposition, the initial set-up is quite simple. However, data communication is required from one processor, with a given computational domain *A, to* all the processors whose computational domains share a boundary with **A** at each time step. The data that must be communicated is equivalent to the field components at the shared boundary with *A*.

The FE method is more complicated, as the distribution of the initial mesh cannot simply be based on a partitioning of physical space. Once this problem has been solved, and the mesh or matrix is distributed, the solution of the matrix can be performed using standard parallel numerical libraries.

- Performance, including comparison with other parallel and sequential computers;
- An estimate of scaling to larger systems, since the Beowulf system is only 16 processors at this time; and
- User experiences with this class machine (non-commercial, not vendor-supported);

are included among the results discussed in this paper.